What is claimed is:

1. A method for automatically controlling the output of a continuous process that requires mixing of a solid or liquid component with a liquid carrier component, the method comprising the steps of:

a.) setting a quantitative target for weight-% of one or more solids and/or concentration of one or more liquids to the liquid carrier component;

b.) continuously mixing said solids and/or liquids with the liquid carrier component;

c.) determining the true density, ρ, by employing equation (14)

$$\rho = \frac{1}{V} \qquad (14)$$

wherein the gas-free volume of fluid, V, is calculated from equation (12)

$$V = V_{t1} - V_1 = \left(\frac{1}{\rho_1} - \frac{nRT}{P_1}\right) \qquad (12)$$

wherein R is the Ideal Gas Law constant, and

$$n = \frac{P_1 P_2}{RT(P_2 - P_1)}\left(\frac{1}{\rho_1} - \frac{1}{\rho_2}\right) \qquad (11);$$

wherein P_1, P_2, ρ_1, ρ_2, and T are measured values;

d.) calculating the weight-% of solids and/or the liquid concentration in the mixture from the true density ρ so determined;

e.) comparing the calculated weight-% solids or concentration to the target weight-% solids or concentration; and,

f.) if the calculated weight-% solids or concentration is greater or less than the target weight-% solids or concentration, lowering or raising the amount of solids or liquids mixed in step b.).

2. The method of claim 1 for continuously coating a substrate, which method comprises:

a.) setting a quantitative target for weight-% of one or more solids to be coated onto a substrate;

b.) continuously applying the solids to the substrate via a carrier fluid;

c.) measuring the apparent density of the slurry;

d.) determining the true density of the slurry;

e.) calculating the weight-% of solids in the slurry in the manner recited in claim 1;

f.) comparing the calculated weight-% solids to the target weight-% solids; and,

g.) if the calculated weight-% is greater or less than the target weight-%, lowering or raising the amount of solids applied in step b.).

3. The method of claim 2, in which the substrate is a paper web and the solids component comprises kaolin clay, calcium carbonate, titanium dioxide, or alumina trihydrate.

4. A method of determining the gas-free true density within a 2- or 3-phase fluid containing one or more incompressible solids and/or liquids and one or more compressible gases, such as a suspension of solids and entrained gases in a liquid carrier or a solid powder in a gaseous carrier, the method comprising the steps of:

subjecting a mixture of incompressible and compressible components to two different pressure states,

measuring the temperature, pressure and apparent density of the mixture at each of the two pressure states, and

determining the gas-free density of the incompressible component(s) by using equation (14)

$$\rho = \frac{1}{V} \qquad (14)$$

wherein the gas-free volume of incompressible component, V, is calculated from equation (12)

$$V \;=\; V_{t1} - V_1 \;=\; \left(\frac{1}{\rho_1} - \frac{nRT}{P_1}\right) \qquad (12)$$

wherein R is the Ideal Gas Law constant, T is the measured fluid temperature, and

$$n = \frac{P_1 P_2}{RT(P_2 - P_1)}\left(\frac{1}{\rho_1} - \frac{1}{\rho_2}\right) \qquad (11)$$

where P_1 and P_2 is ambient pressure, and ρ_1 and ρ_2 are mixture densities.

5. A method for automatically controlling the output of a continuous process that requires mixing of a solid or liquid component with a liquid carrier component, the method comprising the steps of:

a.) setting a quantitative target for gas-free true density of the mixture;

b.) continuously mixing said solids and/or liquids with the liquid carrier component;

c.) determining the true density, ρ, by employing equation (14)

$$\rho = \frac{1}{V} \qquad (14)$$

wherein the gas-free volume of fluid, V, is calculated from equation (12)

$$V \;=\; V_{t1} - V_1 \;=\; \left(\frac{1}{\rho_1} - \frac{nRT}{P_1}\right) \qquad (12)$$

wherein R is the Ideal Gas Law constant, and

$$n = \frac{P_1 P_2}{RT(P_2 - P_1)}\left(\frac{1}{\rho_1} - \frac{1}{\rho_2}\right) \qquad (11);$$

wherein P_1, P_2, ρ_1, ρ_2, and T are measured values;

d.) comparing the calculated true density to the target true density; and,

e.) if the calculated true density is greater or less than the target true density, lowering or raising the amount of solids or liquids mixed in step b.).

6. The method of claim 5 for controlling the output of a continuous process for preparing a syrup, which method comprises:

a.) setting a quantitative target for density of carbohydrates and/or carbohydrate-containing liquids to be blended into a syrup;

b.) continuously supplying the carbohydrate and/or carbohydrate-containing liquid and a dilution liquid to a vessel and mixing said liquids to form a slurry;

c.) measuring the apparent density of the slurry at two pressure states;

d.) determining the true density of the slurry;

e.) comparing the calculated carbohydrate slurry density to the target carbohydrate slurry density; and,

f.) if the calculated carbohydrate density is greater or less than the target carbohydrate density, lowering or raising the amount of carbohydrates and/or volume of carbohydrate-containing liquids supplied in step b.).

7. The method of claim 1 for controlling the output of a continuous process for preparing a syrup, which method comprises:

a.) setting a quantitative target for a concentration of one or more carbohydrates and/or carbohydrate-containing liquids to be blended into a syrup;

b.) continuously supplying the carbohydrate and/or carbohydrate-containing liquid and a dilution liquid to a vessel and mixing said liquids to form a slurry;

c.) measuring the apparent density of the slurry;

d.) determining the true density of the slurry;

e.) converting this true density to the calculated carbohydrate concentration;

f.) comparing the calculated carbohydrate concentration to the target carbohydrate concentration; and,

g.) if the calculated carbohydrate concentration is greater or less than the target carbohydrate concentration, lowering or raising the amount of carbohydrates and/or volume of carbohydrate-containing liquids supplied in step b.).

8. The method of claim 7, in which carbohydrates comprising sucrose and carbohydrate-containing liquids comprising corn syrup and high fructose corn syrup are mixed with a dilution liquid comprising water.

9. A method of determining the amount of gas entrained within a fluid, the method comprising the steps of:

subjecting a gas-fluid mixture to two different pressure states,

measuring the temperature, pressure and apparent density of the mixture at each of the two pressure states, and

calculating the volume percentage of said gas in said fluid by using equation (15)

$$x\% = \frac{V_s}{V_s + V} \qquad (15)$$

wherein V is the volume of the gas-free liquid , determined by Equation (12)

$$V = V_{t1} - V_1 = \left(\frac{1}{\rho_1} - \frac{nRT}{P_1}\right) \qquad (12)$$

wherein R is the Ideal Gas Law constant, and

$$n = \frac{P_1 P_2}{RT(P_2 - P_1)}\left(\frac{1}{\rho_1} - \frac{1}{\rho_2}\right) \qquad (11);$$

wherein P_1, P_2, ρ_1, ρ_2, and T are measured values; and

$$V_s = \frac{P_1 V_1 T_s}{P_s T} \qquad (13);$$

wherein Ts and Ps are standard temperature and pressure, respectively, and

$$V_1 = \frac{nRT}{P_1} \quad .$$

10. The method of claim 9, wherein said two pressure states differ from one another by at least 1.0 psi, preferably at least 1 atmosphere.

11. The method of claim 9, wherein said two pressure states differ from one another at least to the extent that the two different apparent densities of said liquid differ from one another by at least 0.2%, preferably at least 0.5%.

12. A method for controlling the entrained gas content of a liquid or slurry being flow-processed, the method comprising the steps of:

a.) setting a quantitative target for the free gas content of said liquid or slurry;

b.) continuously flowing said liquid or slurry and mixing an antifoam agent therewith;

c.) determining the volume percentage of free gas, $x\%$, from equation (15)

$$x\% = \frac{V_s}{V_s + V} \qquad (15)$$

wherein Vs is the volume of free gas under standard conditions and V is the gas-free volume of the liquid carrier component;

e.) comparing the calculated free gas content to the target free gas content; and,

f.) if the calculated free gas content is greater than the target free gas content, increasing the amount of antifoam agent mixed in step b.).

13. The method of claim 12, wherein the liquid or slurry being flow-processed is a slurry of kaolin clay, calcium carbonate, titanium dioxide, or alumina trihydrate being supplied as a coating to a paper substrate.

14. A dual core-module apparatus comprising: an apparatus having piping for processing 2- or 3-phase fluids at a dynamic state, said apparatus including two core-modules each comprising a density and temperature gauge having a pressure gauge located upstream thereof and a pressure gauge located downstream thereof, said two core-modules being operatively joined together by a pressure changing device.

15. A single core-module apparatus comprising: an apparatus having piping for processing 2- or 3-phase fluids at either a dynamic or static state, said apparatus including a density and temperature gauge having a pressure gauge located upstream thereof and a pressure gauge located downstream thereof, said apparatus further including a pressure changing device being either a fluid control valve located either upstream of the pressure gauges or downstream of the pressure gauges or both or an optional pump.

16. A measurement procedure of obtaining data, on a continuous basis, for use in determining amounts of gas entrained or dissolved in a 2- or 3-phase fluid, which procedure comprises the steps of:

providing an apparatus according to claim 14;

processing the said fluid at a flow rate such that the pressure level differs between each of the dual core-modules by at least 1 psi or at least to

the extent that two different apparent densities of said fluid differ from one another by at least 0.2%;

collecting temperature, pressure and apparent density data from the first core-module while operating at steady-state conditions;

collecting, SIMULTANEOUSLY, temperature, pressure and apparent density data from the second core-module while operating at steady-state conditions; and

calculating entrained gas and true density using the algorithms (11)-(15).

17. A measurement procedure of obtaining data, at a dynamic state, for use in determining amounts of air entrained or dissolved in a 2- or 3-phase fluid, which procedure comprises the steps of:

providing an apparatus according to claim 15;

processing the said fluid through the core-module;

collecting temperature, pressure and apparent density data at a first pressure level while operating at steady-state conditions;

changing the pressure so that the pressure levels differ from one another by at least 1 psi or at least to the extent that two different apparent densities of said fluid differ from one another by at least 0.2% by either adjusting downstream/upstream pressure or increasing/reducing the flow rate;

collecting temperature, pressure and apparent density data at a second pressure level while operating at steady-state conditions; and

calculating entrained gas and true density using the algorithms (11)-(15).